

## Practices, knowledge and values. Teaching Technology for Human Development to engineering students.

A. Pérez-Foguet<sup>1</sup> and A. Saz-Carranza<sup>2</sup>

<sup>1</sup> E.T.S. Enginyers de Camins, Canals i Ports de Barcelona, Dept. Matemàtica Aplicada III, Universitat Politècnica de Catalunya, C2-210B, Campus Nord UPC, 08034 Barcelona, Spain  
e-mail: [agusti.perez@upc.es](mailto:agusti.perez@upc.es), - Web page: <http://www-lacan.upc.es>

<sup>2</sup> Instituto de Dirección y Gestión Pública, ESADE,  
Av. Pedralbes 62, Universidad Ramón Llull, 08034 Barcelona, Spain  
Email: [angel.saz@esade.edu](mailto:angel.saz@esade.edu)

**Key words:** Higher education, Education for development, Technology for human development, Development non-governmental organization, Civil engineering, Cross-sector collaborations

**Abstract.** *Technology is gaining ever-more attention in international development strategies, together with networking and local capacity building. The concept of Technology for Human Development (THD), deeply grounded in the Human Development perspective, is emerging as an approach that captures the great contributions of technology in a sustainable manner, and is gradually taking over the Appropriate Technology concept. The promotion of THD is exemplified by presenting two interconnected cases: the Education for Development (ED) program of Engineering without Borders Spain (ISF-Spain) and the Promoting ED program of the Civil Engineering School of the Technical University of Catalonia (UPC). The two cases, applied at national and local levels, respectively, illustrate how THD may be furthered in practice and how two different actors, a Development Nongovernmental Organisation (DNGO) and a Civil Engineering School, can partner up and create synergies to implement THD programs.*

### INTRODUCTION

During the last years, the role of technology in the international development sector has increased in importance. Two recent annual reports published by international organisms highlight the role of engineering when analyzing the state of the world from a development perspective (United Nation's Development Program, UNDP, 2001; and World Bank, 2004). Similarly UNESCO's (2003) "Engineering for a Better World" and the InterAcademy Council's (2004) "Inventing a better future", seem to support this trend. In all proposals technical capacity building is a fundamental concept. Following this trend, engineering schools and engineering curricula should aim at developing personal and social capacities, a part from technical ones, and should include integral learning processes framed within a human and sustainable development perspective.

The different engineering approaches on poverty reduction and human development can be reinterpreted using the concept of Technology for Human Development (THD).

The concept has recently grown in popularity as an alternative triangular relationship between Science, Technology and Society. The diffusion of the Human Development concept through the UNDP publications during the nineties questioned the previously used term Appropriated Technologies for being too reductionist. In section two, the origin and concept of THD are presented (Pérez-Foguet, 2004). Moreover, the three application channels of THD are described: practical experience (cooperation and humanitarian projects and programs, and advocacy on public policies and strategies), knowledge management (development of appropriate technologies, and specific training and research programs) and promotion of civic ethics (educational programs at undergraduate level, and awareness-raising in the engineering sector).

The concept of “Education for Development” (ED) and its obvious link with THD are also introduced. ED can be defined as “a constant educational process that favors the understanding of the economic, political, social and cultural relations between North and South, promotes values based on solidarity and social justice, and searches for new lines of action in order to promote human sustainable development” (Boni y Baselga, 2003). Higher education has recently incorporated education on sustainability, as Barnes et al. (2000), Perdan et al. (2000) and Dohn et al. (2003) show, and whose experiences are closely related to the ones presented here. Also similar are other experiences rooted in the value-based education approach (Hoole, 2002).

In fact, in the third section, the experience of the development nongovernmental organization Engineers Without Borders Spain (ISF-Spain) is presented. ISF-Spain has strongly promoted, at a national level, ED as a fundamental component of its drive for THD. One of its multiple lines of activities has centered on advocating for higher education institutions to adopt an ED approach. Among the different higher education institutions, which have, in some sense, included ED in their approach and modus operandi, the Technical University of Catalonia (UPC) is highlighted for its wide range of proposals. In the fourth section, the program Promoting Education for Development, locally implemented at the UPC’s Civil Engineering School in Barcelona from 1999 to 2002, is described.

## **TECHNOLOGY FOR HUMAN DEVELOPMENT**

### **Basic concepts**

The concept of human development, which “places at its core the human being and understands development as a process by which the options of people are enlarged” (Prats, 2001), emerges at the end of the 20<sup>th</sup> century to confront the classical economic conception of development. Human development emphasizes that the ultimate objective must be the people, and it is highly related to Sen’s (2000) concept of freedom as the increase in capacities, both at individual and collective levels.

One of the basic methods available to measure Human Development (HD), and one of the most frequently used, is the Human Development Index (HDI), consisting of three factors: life expectancy; the possibility to lead a life with dignity (by accessing sufficient economic resources); and the access to knowledge (via education). Another way of defining HD, is to conceive it as a set of preconditions, means and ends. Six dimensions can then be identified, which compose HD: security and equity as preconditions; productivity and cooperation as means; and sustainability and auto-dependence as ends (Boni and Ferrero, 1997). This conceptualization is process-oriented and has the added value of highlighting the links between technology and HD.

According to UNESCO, technology is the sum of the capacities, knowledge, tools and procedures necessary to produce goods and services. Benavides (1998) defines technology as “a system of knowledge and information induced from research, experimentation and experience that allows to create a replicable process to produce goods and services”. Hence, technology may be characterized according to three elements: knowledge; a human activity to which the knowledge is applicable; and a practical end, which then generates results.

From UNESCO’s international classification it may be concluded that technology is related to all engineering and architecture professions and university degrees. Engineering, which is closely related to but is distinct from technology, is defined by the Accreditation Board of Engineering and Technology (ABET) as “the knowledge of mathematical sciences acquired through experience, study or practice and intelligently applied in order to produce processes that by optimally using materials and natural forces and by abiding by ethical, physical, economic, environmental, human, political, legal and cultural restrictions may result in benefits for humanity.”

### **The relationship between science, technology and society**

In order to further in the study of the relationship between HD and technology, it is necessary to refer to the triad made up by Science, Technology and Society (STS) (Moñux, 2000). The study of STS has its origin in the 60s, after the first nuclear accident in 1957, and is based on the philosophical and sociological analyses of the role of technology in the western development model. By the end of the decade, several non-governmental organizations were founded to deal with STS in an applied sense, such as ITDG (Intermediate Technology Development Group) in 1966 and Greenpeace in 1969, as well as the first environmental and technical innovation governmental agencies.

At present, following the development of IT and biomedicine, there is a renewed debate between, on the one hand, the techno-optimists, exemplified by the motto used in the Chicago World Show of 1933 “Science discovers, Industry applies, and Humans adapt” (Rip, 2000), and, on the other hand, critics of the dependence the current system has on technological developments, and by the ever-larger role technology is acquiring in society. As a response to this tension, several public policies have been produced, which attempt to introduce social participation in the technological advance (Collingridge, 1980; López Cerezo et al., 1998; and Rojo, 2001), as, for example, policies produced by the European Union in this sense.

### **The evolution of the THD concept**

Just as the relationship STS has evolved, the relationship between technology and development has also evolved during the years (Motta, 1996). The term THD has increasingly complemented that of appropriate technology (AT). During the critical decade of the 60s, when the destructive side of western technological development was strongly questioned, E. F. Schumacher comes up with the term Intermediate Technology and founds ITDG. However, the term Intermediate Technology deteriorates as different political connotations are ascribed to it and evolves into AT, which becomes popular during the later part of the 20<sup>th</sup> century. AT is understood in both a weaker sense, as technological solutions to the main problems faced by the poor in developing countries, and in a stronger sense, which refers to the coherence and suitability of modern technology to the overall conditions of developing countries.

However, AT in the weaker sense has been evermore criticized, and new terms have

been proposed. The appearance of the concept of HD has questioned the role of technology in development since there isn't a direct correlation between economic growth and human development, and therefore the relationship between scientific, technological, economic and social progress is not linear, as it had been assumed. In 2001, the UNDP's report demanded to put the technological advances at the service of Human Development. The same idea was expressed by Kofi Annan at the Davos World Economic Forum in 2002: to help mobilize global science and technology in order to face the interrelated famine, disease, environmental destruction and conflict crises that are blocking the progress of the developing world.

### **Applying THD**

THD is based on the fundamental idea that technology can be part of the solution to the problems of under development and demands a revision of technology role, in order for it to be redirected towards the achievement of HD. This idea of technology has affected classical international development strategies. It is worthwhile emphasizing that THD is not substitutive of AT, rather it is complementary to it. Moreover, THD may be approached both from a HD perspective as well as from a multi-dimensional perspective.

#### *The Human Development approach on THD*

Approaching THD from a HD perspective implies looking at THD on the basis of the following requirements:

- Technology that guarantees basic rights and access to basic services with a minimum of dignity (related to the life expectancy factor of the HDI).
- Technology that assures minimum production and social participation capacities (related to the HDI factor regarding the access to a minimum of economic resources).
- Technology that facilitates sustainability and autonomy (linked to the increase in the education factor of the HDI, understood as the capacity to manage the physical, social, cultural and technological environment).

All technologies must fulfill all three requirements, although some may be more clearly related to one of the three requirements. For example, energy sector related technologies must not only guarantee an equitable access to the service but must also incorporate social participation, and promote sustainability and auto-dependence.

#### *The multi-level approach on THD*

A complementary approach is that of analyzing whether a given technological sector complies with THD at different levels. We have termed this approach as multi-level approach. THD is multi-level in nature since in the current globalized context, it is of fundamental importance to keep in mind the diverse nature of the local, regional and global levels, in particular when dealing with technology-intensive solutions that may vary greatly according to the level they are being applied at. Moreover, the multi-level approach highlights the diversity of social actors involved in the promotion of THD.

Furthering THD in the international development field may be done through three fundamental channels: actions; knowledge; and values (Quintanilla, 1998). Combining the two previously mentioned approaches on THD and the three application channels,

THD can be conceived as a three-dimensional cube (see Figure 1).

Hence, when working in the development field from a technological approach framed within THD the basic applications are the following:

- Operational channel (ACTIONS)
  - Carry out development projects that aim at covering the access to basic services, in an equitable, sustainable manner and promote the auto-dependence of the end users.
  - Define development strategies and policies, related to technological issues, in a participative manner and frame technological progress in human rights.
- Cognitive channel (KNOWLEDGE)
  - Generate appropriate knowledge regarding HD and promote reflection on the proprietary rights and copyrights of it.
  - Transfer of information, technology and knowledge, both between North and South as between South and South.
- Valorative channel (VALUES)
  - Adopt ethic based educational programs (as ED) within the techno-scientific area, in particular within the higher education area.
  - Raise awareness regarding the role of technology in both situations of inequality and exploitation, as well as in situations of equality and fairness.

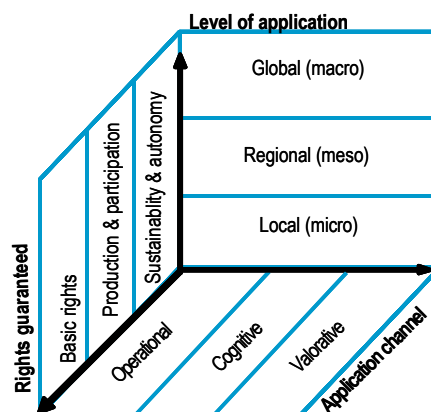


Figure 1: The three dimensions of THD.

## Development projects, programs and strategies

The urgent need to promote HD does not allow focusing solely on theory building and analysis with respect to THD. Therefore, a first area of work must be that of ACTION. The action in favor of HD must be carried out at different conceptual levels; projects, programs and strategies, which must be coherent between each other. Moreover, all the different stakeholders must be taken into account.

The most relevant sectors, which require action from a THD perspective are: 1) territory and environment management, 2) social equipments and housing, 3) water and sanitation, 4) energy supply, 5) transport and commercialization systems, 6) local production capacity building, and 7) specific IT for knowledge management. Moreover, the different sectors share operative characteristics according to where they are found along the following three continuums: 1) the security – sovereignty continuum (equitative access – sustainable and auto-dependent access), 2) the urban – rural continuum (high population density – low density), and 3) the emergency aid – risk management continuum.

## Appropriate technological knowledge management

Since power belongs to those who generate and use their own KNOWLEDGE (Levy, 1994), it is necessary to incorporate knowledge generation capacities in development processes in order to avoid creating dependence (Souza y Cheaz, 2000, Carrión y Palacios, 2003). Developing knowledge generation capacities becomes more central as intellectual technologies takeover material technologies in the post-industrialist society. Given that creativity increases more due to working groups' interaction, rather than individual action, social technologies, those that allow a greater participation of social actors, are also of great importance. Therefore, from an HD perspective, not only is the provision of basic services and infrastructure relevant, but also creating IT-related capacities is a high priority.

HD requires that both knowledge and the learning process, through which it is generated, allow and promote the enhancement of freedom and autonomy, both at an individual and collective level. Rather than focusing on “learning” (Senge, 1990), it is necessary to focus on “knowledge generation adapted to a changing context” (Nonaka y Takeuchi, 1995) in order to actually increase the transformation capacities of the participants. Therefore, based on a constructivist paradigm, knowledge transfer must be understood as a co-generation of knowledge aimed at endogenously developing the participants, as opposed to the positivist paradigm where, from an authoritative epistemological stance, reality is objectively observed, described, explained, predicted and controlled and no ethical commitment exists. Hence, the different actors involved in knowledge generation and HD, such as universities, organizations, local authorities, communities, beneficiaries and other participants must be proactively coordinated.

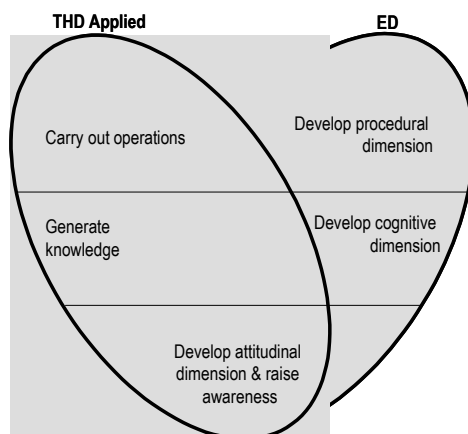


Figure 2: The fit between THD and ED

## Education and awareness-raising in search for change

A change in attitudes and VALUES worldwide is necessary if a sustainable development of communities is to be reached. Education for Development (ED) is based on the basic premise that the people and communities from North and South must be made consciously co-responsible. ED, which must not be confused with independent educative activities regarding international development, combines different methodologies that aim at tri-dimensionally developing the participants of the teaching-learning process (and which are similar to the three THD application channels, see Figure 2): cognitive, procedural, and attitudinal (Boni y Baselga, 2003). Regarding the

latter dimension, the one related to values, ED is closely related to the environmental education, value-based education and education for peace perspectives.

In the case of the Spanish engineering higher education, the firsts experiences in promoting ED in engineering during the early nineties were presented during the 1<sup>st</sup> Congress in Education for Development in University, organized by the University of Valladolid and ISF in 2001. However, support for such ED initiatives is still, in general, insufficient. Moreover, there still is some confusion regarding the different terms used (Freres and Cabo, 2003), and some actors, which are supposed to be central due to their role in pedagogical issues, such as the Institutes of Education Sciences of Spanish universities, do not include ED in their agendas.

## **THE ISF-SPAIN NETWORK: ED IN PRACTICE**

As mentioned, ISF-Spain has been one of the major promoters of ED in engineering mainly around the Civil Engineering Schools of Barcelona and A Coruña, the Mechanical Engineering Schools of Valencia, Barcelona, Valladolid and Madrid, and that of Telecommunications in Madrid. However, it was not until 2001, after the congress cited above, when a unified frame for action at a country level was defined between the different regional associations ISF-Spain.

### **The ISF-Spain network**

ISF-Spain is a development non-governmental organization (DNGO) of average size for Spanish standards with an annual budget of around two million euros, 1500 members, and 400 volunteers scattered along the 11 regional associations. ISF has strong links with universities and engineering schools, as well as with engineering associations, business, and third sector organizations. One of the main lines of action are ED activities in the engineering sector, which account for more than 10% of the financial resources and probably more than 20% of the human resources. This strongly links ISF-Spain with the higher education institutions.

The ISF-Spain network is a slightly structured, minimally formalized cooperative network, with a centralized coordination unit. In parallel, ISF-Spain is part of an informal and unstructured social network of information sharing, which includes several development organizations from the North such as International Water and Sanitation Center (IRC) in The Netherlands, ITDG at UK, and, via the Spanish Engineering Institute, the World Federation of Engineering Organizations (WFEO) associated with UNESCO. On the other hand, ISF-Spain is part of the unstructured and informal international network of Engineers Without Borders International, which includes all country-level organizations. ISF-France was constituted during the '80s, while in Spain, several separate organizations, as ISF-Madrid, ISF-Catalunya and ISF-Aragón, were constituted in parallel in 1992, which later would create the Spanish network. Later, other ISF have been created in other countries, such as ISF-Italia, and during the past five years Engineers Without Borders Canada, UK, USA and several other countries have emerged. It is worth while mentioning that only ISF-Spain, together with ISF-Italy, are networks of regional organizations themselves, since the other ISF take the form of hierarchical single organizations. This fact together with other differences hinders deeper coordination at an international level and makes the network highly heterogeneous. At present Engineers Without Borders International has no formal governing body.

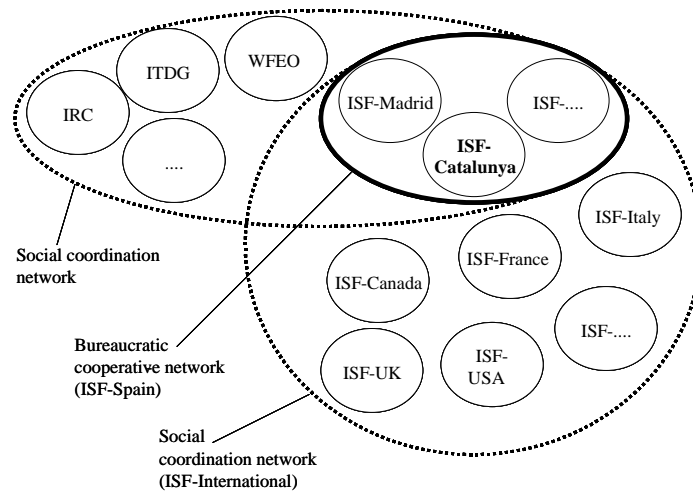


Figure 3. ISF-Spain's networks.

## ED activities

A brief description of the major lines of action of ISF-Spain's 2004 Program of Education for Development follows. Although the program has involved 21 Spanish universities, only the more involved universities are cited.

- Supporting the inclusion of ED approaches in degree programs:
  - Training of faculty (specific courses for faculty, such as the “Teaching THD” course for the faculty of the technical universities of Catalonia, Valencia and Madrid (Boni et al., 2004) and the seminar “Value-based education in technical fields: the challenge of the Higher Education European Space” co-organized in June 2004 together with the Institute for Education Sciences of the UPC).
  - Mainstreaming (incorporating aspects of ED in compulsory and optional technical courses, see Oliete et al. 2004 for some specific details).
  - Specific courses (supporting the existence of 14 optional courses regarding International Development, and Development Project Management).
- Supporting complementary education:
  - Offering three postgraduate distance-learning degree programs on THD in collaboration with the Open University of Catalonia, and participating in several other postgraduate degrees.
  - Annual conference in THD (together with the technical universities of Madrid and Catalonia), and several seminars and minor conferences in different schools.
- Internships in developing countries:
  - Short-term internships for small groups of volunteers, of around two months with a strong technical and applied component and which allow to experience the living conditions of the communities with whom ISF-Spain works. These internships are linked to programs ISF-Spain executes, such as the National Water Plan in El Salvador, the Promotional Program of Urban Basic Services in Cameroon, and the IT-related Spanish-American Health Link Program in Latin America (EHAS).
  - Final year projects of three to six months in length at DNGO and International Organizations. The projects can be related to technical studies and long-term development programs headed by ISF-Spain or by its partners.
- Volunteering and social participation in Spain.



- Volunteering work and internships in ISF-Spain itself and other NGO.
- Promotion of volunteering and social participation programs by co-founding the offices for Social Action at the A Coruña University and the UPC (Pérez-Foguet and Peña, 2003).
- Support for research in THD
  - The creation, together with professional engineering associations, of the national awards for final year projects and PhD theses on THD.
  - Creating and editing the Spanish-written International Journal in THD distributed throughout Spain and Latin America.
  - Creating documentation centers on THD, as the one established jointly with the UPC.

## **CIVIL ENGINEERING SCHOOL OF BARCELONA: ED IN ACADEMY**

The strategic plan for 1999-2002 of the Civil Engineering School of Barcelona (ETSECCPB) was a result of the negotiation between the school, the UPC (to which the school belongs) and actors from the civil society, and is a good example of inter-organizational and cross-sector collaboration and the implementation of an integral plan of ED covering both degree programs and non-formal education. This initiative was rooted in the previous experiences of supporting isolated international development, sustainability and environmental activities (Capdevila, 1999). The inclusion of these aspects in the strategic plan gave the ED-related activities, such as the courses and the documentation center, institutional and economic support.

### **ED program '99 – '02**

The principal actors that participated in the 99-02 ED program included in the strategic plan were (Pérez-Foguet, 2001): 1) The school, who is in charge of the five-year degrees in Civil Engineering and Geological Engineering, the three-year degree in Public Works Engineering, as well as the postgraduate degree and PhD in Civil Engineering. 2) Two NGO strongly rooted in the university with specific volunteering programs for university students: ISF-Spain and WAFAE (dedicated mainly to promote cooperation between Spain and Northern Africa). 3) The different departments of the school, such as the departments of Applied Mathematics, Water, Urbanism and so on. 4) The International Development Center (CCD) of the UPC, in particular by financing international development and awareness-raising projects. Other actors were involved later on, such as the Victoriano Muñoz Oms Chair, which promotes the teaching of humanistic values in engineering, and the Social Action office “Univers”, dedicated to promote cultural and sports activities, and recently also social participation.

The strategic plan was divided into four themes: Improvement and flexibilization of studies; integration with the labor market; personal and institutional quality of life; and future needs and social integration. The latter theme constituted the Program of ED, which had as its main goal “To incorporate into the School awareness-raising and teaching regarding international development and appropriate technologies”. The specific objectives were:

- O1. Support awareness-raising campaigns in the school.
- O2. Include a specific education on international development, consisting of coherent and complete group of optional courses.
- O3. Transversally integrate, in all degrees, specific aspects concerning international

development and appropriate technologies issues, based on concrete practical cases.

- O4. Promote technical studies regarding international development that may assist real programs carried out by NGO.
- O5. Promote the inclusion in DNGO and International Organizations of students trained in international development.
- O6. Support the creation of a documentation center in international development.

The strategic plan was then implemented via general agreements between the school and UPC, which defined 46 different lines of action. Out of these 46, seven lines of action were directly related to the ED program, and it was via these that the program was actually channeled and implemented. The school led directly the necessary activities to fulfill objectives O2, O3, and O6. These were: offering several optional courses on THD (O2); transversally incorporate THD issues by carrying out specific sessions on different THD subjects and by creating materials with THD cases regarding many different civil engineering subjects; such as hydraulics, topography, urban services and infrastructure (O3); and leading the creation of a documentation center on THD (O6). Regarding the other objectives included in the plan, O1, O4, and O5, they were led by different DNGO, primarily ISF-Spain, with the help of the university's Center for International Development (CCD) and Catalonia's autonomous government, and, to a lesser extent, the school's assistance.

Regarding the consecution of O1, a total of 37 open sessions were organized during the three years of the program. The sessions were related to THD issues in general, including not only technical issues but as well as political issues such as the role of the public administration in development or the role of business. They were coordinated with the two optional courses that are described below. Moreover, the 2<sup>nd</sup> International Conference on Technology for Human Development was organized at the university by ISF-Spain around the key words water and infrastructures (Pérez-Foguet et al., 2003). Moreover, ISF-Spain carried out seven awareness-raising campaigns financed by the CCD.

The two optional courses on THD were offered during this three-year period, in line with objective O2, as was the fact that among the different optional courses offered by the school fourteen were grouped thematically in line with the ED program: one group related with international development and another with abilities and humanistic values in engineering.

Objective O4, "Promote technical studies regarding international development that may assist real programs carried out by NGO", has been achieved, in particular in the thematic areas of rural water distribution, infrastructure and urban services, and construction materials and small-scale civil engineering. These studies, which are mostly final degree projects or thesis, have been carried out in partnership mainly with ISF-Spain, assisting its programs, and with the CCD, which has financed them. Two students from the school were awarded the National Awards for Final Year Projects on THD. However the fit between the academic requirements and the needs of the specific programs of the NGO do not allow for a straightforward generalization of such initiatives.

The collaboration of engineering students with DNGO (related to objective O5) has not been monitored and the role of the school has been limited to informing the students about all possible vacancies. The overall number of students that got involved with DNGO is approximately 30 per year, about 8% of the annual student entrance. Regarding this issue, UPC and ISF-Spain set up the Office for Social Action at the end

of the program, whose principal task is to centralize volunteering vacancies of NGO and match them with volunteering offers, as well as doing the selection, follow-up and evaluation of the volunteers. The involvement of students and graduated students in International Organizations there is very little known.

### **International development, engineering and development projects**

The two optional courses mentioned before must be highlighted due to their high acceptance among the students and the faculty. The courses were “International aid, engineering and development” and “Development projects: concepts and methodologies”. Both courses were 45 hours long, 36 of which were classroom hours, delivered in three-hour sessions. Given the need of such education in engineering schools in Spain, and the almost total lack of them, a general all-inclusive 13 theme conceptual map was specifically designed and adapted, from other academic fields, to engineering. The first course included 11 themes while the second course, highly applied and participative in nature, focused on the last two.

#### *“International Aid, Engineering and Development” course*

This course, taught during the autumn term, aims at providing a general introduction to the role played by engineering in international development and human development. As mentioned, the course is composed by 11 themes. The first theme introduces the state of the world and in particular its growing inequalities and the possible causes for this. The next three themes cover the concepts of globalization, governance and development and introduce the mesh of international organizations, such as the World Bank, the United Nations, and The World Trade Organization. The fifth and sixth themes are dedicated to the role of technology and infrastructure in development processes. These themes are based on the UNDP and World Bank reports of 2001 and 2004, respectively. These first six themes constitute the first of the two blocks of the course, which is more conceptual and general in nature.

The second block of themes has a more concrete approach and focuses on specific organizations and development strategies. The seventh theme covers international aid based on the UN Millennium Development Goals, while theme eight introduces the principal actors in international development, differentiating among governmental, non-governmental, international and business organizations. The Spanish international development aid is overviewed in the next theme, while the tenth theme is dedicated to the role of the Spanish private engineering sector in international development, including the effects of public policies aimed at favoring the internationalization of Spanish enterprises. The final theme goes through basic concepts in Business Ethics and Corporate Social Responsibility and promotes reflection among the students regarding their personal future position in the private engineering sector. The three-hour sessions had usually a first part dedicated to the theoretical framework of a given subject, followed by a participatory case based second part. The evaluation of the students was based on attendance, essays and a final exam.

#### *“Development projects: concepts and methods” course*

This second course aims at introducing some basic decision-making and planning tools for managing development projects. The course, which is taught during the spring term, covers the logical framework approach emphasizes both efficient management

and participation. It is these two latter concepts that constitute themes 12 and 13. Indeed, these two themes together with the last one of the previous course, Business Ethics and Corporate Social Responsibility, provide the three fundamental pillars that should serve as a basis for the future professional careers of the students: ethics, management skills, and participatory and team skills.

In more concrete terms, the course makes two main contributions. In first place, it attempts to enlarge the number of factors that must be taken into account when making decisions in the engineering sector, decisions that are all-too-often based exclusively on technical factors. A managerial dimension and a strategic dimension are added to the technical dimension in order to cover the three basic dimensions involved when making decisions regarding organizational interventions (Serra, 1998). These two additional dimensions become of even more importance in highly intangible sectors, such as poverty reduction or social inclusion (Serra and Saz-Carranza, 2002). In this sense, from a THD perspective, not only must an intervention involve appropriate technologies, but must also have a strategic objective that aims at building capacity for the beneficiaries and must be managed efficiently and in a participative manner. The second contribution is that it introduces engineering students to intangible results and, in particular, to the social impact of engineering interventions. Hence, social criteria are added to the purely technical criteria during the planning and the evaluation stages of engineering projects.

The course goes through the project cycle, emphasizing the requirement that the project objectives be identified on the basis of stakeholder analyses and grounded in the needs of the beneficiaries. Indicators, necessary to evaluate and monitor interventions dealing with intangible social issues are also highlighted. Methodologically speaking, the course uses case-studies, concrete practical experiences and, role games for more than half of the class-room hours, which is rare in the Spanish engineering higher education.

## CONCLUSIONS

This work has presented the concept of Technology for Human Development as a particular evolution of and a complement to the concept of Appropriate Technologies, and in particular as a fundamental concept in the engineering sector in general and, in particular, in the nongovernmental and higher education sub-sectors. Moreover, it has been shown how an engineering school and a nongovernmental organization have been capable of introducing transversally Education for Development in a higher education context, both at the school-level as at the national level. This has been based on working on practical experiences, values and specific knowledge. Regarding the latter, not only have technical aspects been taken into account but also managerial and relational aspects, as well as political and strategic aspects. Moreover, the exclusively technological approach, typical of Spanish engineering schools, has been widened to include a social dimension when evaluating to the impact of technology.

Although limited and incomplete, this experience and theoretical framework may serve as an example and incentive for other schools and initiatives. The triple triad implicit in the THD approach – science, technology and society; knowledge (cognitive skills), practices (procedural skills) and values (attitudinal skills); and technical, managerial-relational, and political-strategic – together with its multi-level (Macro, meso and micro), multi-disciplinary and multi-sector (private, public and nonprofit) implementation may well be a useful building block towards the search for a sustainable development model.

## ACKNOWLEDGMENTS

The authors, president of Spanish Federation of ISF during 2001-2004 and vice-president of the Catalanian Association of ISF during 2002-2004 respectively, would like to thank the volunteers, members and partners of the ISF network, origin and execution arena of the THD approach, and in particular the Education and Research for Development workgroup. Moreover, we want to thank the Polytechnic University of Catalonia, the Polytechnic University of Madrid and the Polytechnic University of Valencia for their support as well as the Generalitat de Catalunya (Autonomous Government of Catalonia) for partially financing ISF-Spain's program presented.

## REFERENCES

- Barnes, N. J., Phillips, P. S. (2000), "Higuer education partnerships. Creating new value in the environment sector", en *Int. J. of Sustainability in Higher Education*, Vol. 1:2, pp. 182-190.
- Benavides, C. A. (1998), "Tecnología, innovación y empresa", Ediciones Pirámide.
- Boni, A., Acebillo, M., Visscher, J. T., Hidalgo, S., Pérez-Foguet, A., Cañizo, C. (2004) "Estrategias para el impulso de la educación para el desarrollo en la universidad. La experiencia del curso de Formación de Formadores universitarios: Educando en Tecnología para el Desarrollo Humano", el 2º Congreso Nacional Universidad y Cooperación al Desarrollo, Universidad de Murcia.
- Boni, A., Baselga, P. (2003), "La educación para el Desarrollo como estrategia prioritaria de la cooperación", Libro Blanco de la Cooperación al Desarrollo de la Comunidad Valenciana, Generalitat Valenciana.
- Boni, A., Ferrero, G. (1997), "Introducción a la cooperación para el desarrollo", ISF, Servicio de Publicaciones UPV – 97.272, Universidad Politécnica de Valencia.
- Capdevila, I. (1999), "L'ambientalització a la universitat", Di7 Edició, Barcelona.
- Carrión, J., Palacios, D. (2003) "Gestión del Conocimiento y Capital Intelectual".
- Collingridge, D. (1980), *The social control of technology*, St. Martin's Press, New York.
- Dohn, H., Gausset, Q., Mertz, O., Müller, T., Oksen, P., Triantafillou, P. (2003), "Strengthening learning processes in natural resource management in developing countries through interdisciplinary and problem-oriented learning", en *Int. J. of Sustainability in Higher Education*, Vol. 4:2, pp. 106-125.
- Freres, C., Cabo, C. (2003), "Las Universidades de la Comunidad de Madrid y la Cooperación al Desarrollo", Colección Documentos Técnicos, nº 2, Consejerías de Educación y de Servicios Sociales de la Comunidad de Madrid.
- Hoole, S. R. H. (2002), "Viewpoint: Human Rights in the Engineering Curriculum", en *Int. J. of Engineering Education*, Vol. 18:6, pp. 618-626.
- Levy, P. (1994), "L'Intelligence Collective: Pour une Anthropologie du Cyberspace", La Découverte, Paris.
- López Cerezo, J. A., Méndez Sanz, J.A. y Todt, A. (1998), "Participación Pública en Política Tecnológica. Problemas y Perspectivas", *Revista Arbor CLIX*, Vol. 627, pp. 279 – 308.
- Moñux, D. (2000), *Tecnología para el Desarrollo. Hacia una comprensión de las relaciones entre tecnología, sociedad y desarrollo*, Sala de lectura CTS+I, Organización de Estados Iberoamericanos.
- Motta, R.D. (1996), "Epistemología de la Tecnología: Una aproximación a la definición de tecnología y a las nociones de tecnologías adecuadas y/o apropiadas".
- Nanaka, I., Takeuchi, H. (1995), "The Knowledge-Creating Company: How japanese companies create the dynamics of innovation", Oxford University Press, New York.
- Oliete, S., Pérez-Foguet, A., Magrinyà F. (2004) "Opportunities and Challenges for Incorporating Case Studies from Developing Countries in Core Engineering Courses", *Engineering Education in Sustainable Development*, Barcelona.
- Perdan, S., Azapagic, A., Clift, R. (2000), "Teaching sustainable development to engineering students", en *Int. J. of Sustainability in Higher Education*, Vol. 1:3, pp. 267-279.
- Pérez-Foguet, A. (2001), "Educación para el Desarrollo en la Escuela de Caminos de Barcelona. Planificación 2000-2002", 1º Congreso de Educación para el desarrollo en la universidad, ISF – Universidad de Valladolid.
- Pérez-Foguet, A. (2004) "Tecnología para el Desarrollo Humano: promocionando la cooperación al desarrollo en las ingenierías.", en el 2º Congreso Nacional Universidad y Cooperación al Desarrollo, Universidad de Murcia.

- Pérez-Foguet, A., Carrillo, M., Magrinyà F. (Editores) (2003), "Tecnología para el Desarrollo Humano. Agua e infraestructuras", ISF, Barcelona.
- Pérez-Foguet, A., Peña, E. (2003), "Propuesta de educación para el desarrollo en las escuelas de caminos desde la experiencia de Barcelona y A Coruña", Encuentro Internacional de Enseñanza de la Ingeniería Civil, Ciudad Real.
- Pérez-Foguet, A., Saz-Carranza, A., Morales, M. (2004) "Cooperación internacional, Ingeniería y Proyectos de Desarrollo: una propuesta de educación para el desarrollo para las ingenierías", 2º Congreso Nacional Universidad y Cooperación al Desarrollo, Universidad de Murcia.
- Prats, J. (2001), "La Construcción Histórica de la Idea de Desarrollo", Paper nº 34 de la Biblioteca de Ideas, Instituto Internacional de Gobernabilidad.
- Quintanilla, M. A. (1998), "Técnica y cultura", Teorema.
- Rip, A. (2000), Ética, I+DT y evaluación, The IPTS Report, Centro Común de Investigación (JRC) de la Comunidad Europea Vol. 50.
- Rojo, T. (2001), Sevilla 2010: Metrópoli ecológica. Aplicación de la metodología participativa europea EASW, Grupo de Investigación Desarrollo y Cambio Social, Departamento de Sociología, Universidad de Sevilla.
- Saz-Carranza, A. (2003) "Managing the process of inter-organisational collaboration networks: a cross-disciplinary literature review regarding the process and the management dimensions of inter-organisational networks", ESADE Working Paper.
- Sen, A. (2000), Desarrollo y Libertad, Editorial Planeta, Barcelona.
- Senge, P. (1990), "The fifth discipline: the age and practice of the learning organization", Century Business, London.
- Serra, A. (1998) "Gestió dels serveis socials locals. Manual bàsic de referencia", Diputació de Barcelona.
- Serra, A., Saz-Carranza, A. (2002) "Model per a la gestió dels serveis socials a domicili", Diputació de Barcelona.
- Souza Silva, J., Cheaz, J. (2000), "Generación de Conocimiento y Construcción de Teoría en Proyectos de Desarrollo de Capacidad Institucional. La propuesta del Proyecto ISNAR Nuevo Paradigma en el contexto del cambio de época", Servicio Internacional para la Investigación Agrícola Nacional, San José, Costa Rica.